Geometry and Material Requirements of Tracking

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Tracking Reconstruction Meeting

1 What is Tracking?

We consider 'Tracking' to be Finding, Fitting, and Extrapolating tracks within the tracking volume. This does NOT include hit reconstruction in the tracking sub detectors, even though that also uses geometry. This note presumes that the sub detectors provide hits in the appropriate local coordinate system. Tracking also EXCLUDES the precise extrapolation of tracks to outer detectors, as the material and geometric needs for this go far beyond what we as tracking experts can be expected to reasonably know. We do consider providing extrapolation to cylinders and planes as a responsibility of the tracking group.

Tracking is just one of several 'customers' for geometry and material information. To put us in perspective, here's a partial list of users and providers:

1. Mechanical Engineering.
   In some real sense, these guys define the geometry.

2. Monte Carlo.
   These guys need a complete geometric description of the detector, probably not as detailed as the ME specifications. They also need material specification for all detector elements, with a distinction of active and passive volumes.

3. Hit Reconstruction.
   SVT and DCH need description of their specific geometries to be able to reconstruct hits from channel data.

4. Tracking.
   More on this later.

5. Material interaction searches.
   These guys need to know where to expect to find photon conversions, hadronic interactions, etc., and how likely those interactions are.

6. Outer Detectors.
   DIRC, ATC, EMC, and IFR all need to have descriptions of their geometry too, in a frame consistent with the tracking detectors (more on this later).

2 Tracking Geometry Needs

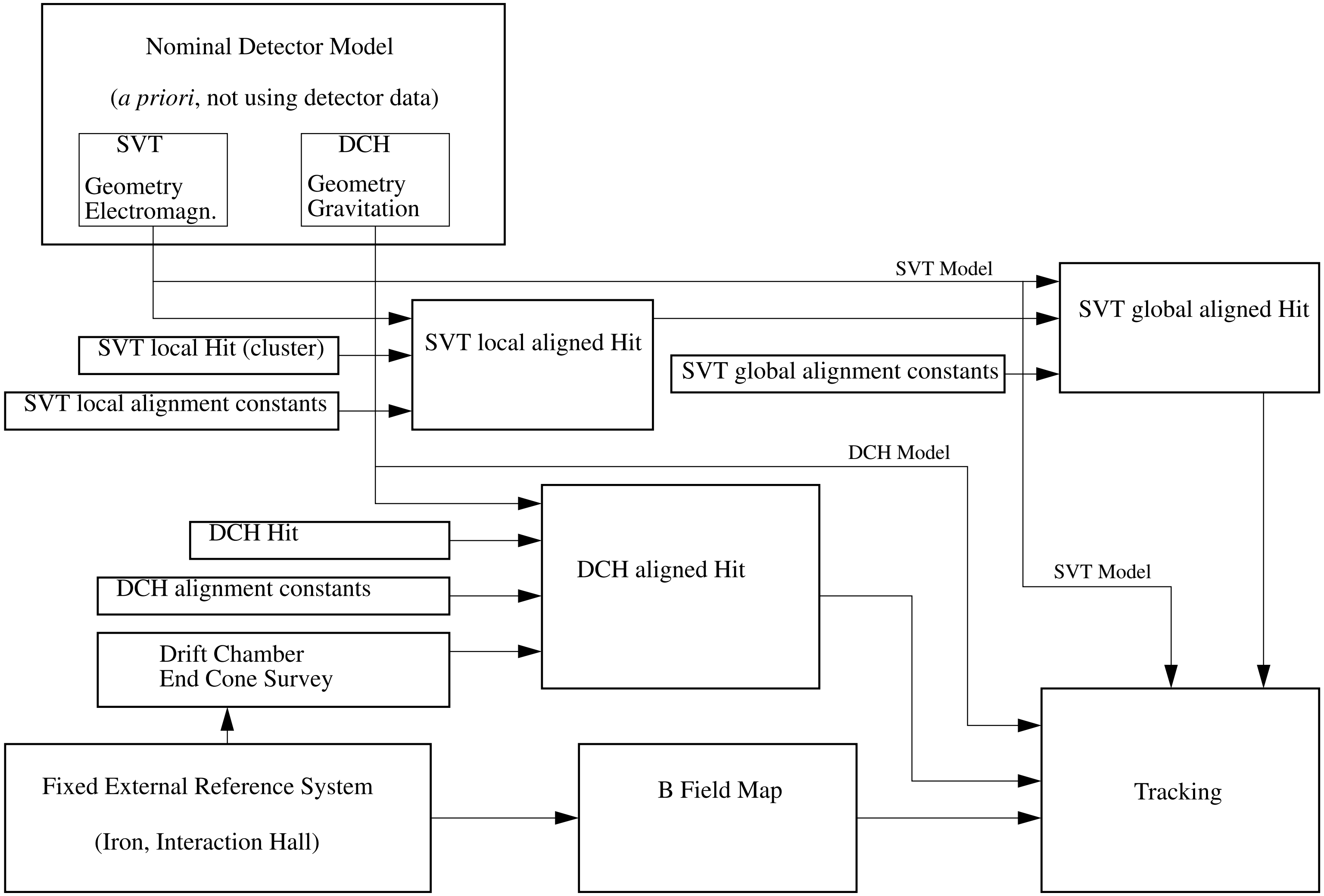
2.1 Coordinate Systems

Tracking requires that SVT and DCH hits ultimately be expressed in a common coordinate system. Extrapolated tracks must be expressed in the same coordinate system as the outer detectors. Real detectors are never precisely where they are nominally supposed to be, and a set of alignment constants is needed to express their true position. Figure 1 describes how we propose to unify these different requirements into a consistent system.

We suppose the existence of a fixed coordinate system, defined in terms of survey markers in the PEP II collision hall. The Babar origin is defined in this system as the interaction point (best guess thereby). Conventions on directions must also be defined in this system. We suppose that the DCH end plate position can be determined directly in this system (by survey). The magnetic field map and the outer detector positions are also presumed to be measured in this system, which then provides the necessary common link.

The coordinate systems can best be understood by following the SVT and DCH hits as they progress towards 'tracking'. SVT hits are first corrected for local mis-alignment. This takes as input the nominal detector geometry and the local alignment constants as well as the local hit position, and gives as output an aligned local SVT hit. A local aligned SVT hit is defined so that the relative position of any two such hits is 'correct'. Another correction for the position of the SVT as a rigid body within and with respect to the DCH is needed to transform to SVT global aligned hits.

The DCH hits have a different path. As with SVT, the nominal geometry plus alignment corrections are used to transform local DCH hits into DCH aligned hits. In addition, DCH aligned hits must be expressed in the fixed external reference system. This requirement assures that all subsequent tracking (and processes like alignment and extrapolation) will be expressed in that frame. It also insures compatibility with the magnetic



Nominal Detector Model
(*a priori*, not using detector data)
SVT
Geometry
Electromagn.
DCH
Geometry
Gravitation
SVT Model
SVT global aligned Hit
SVT local aligned Hit
SVT local Hit (cluster)
SVT global alignment constants
SVT local alignment constants
DCH Model
DCH Hit
DCH aligned Hit
SVT Model
DCH alignment constants
Drift Chamber
End Cone Survey
Fixed External Reference System
(Iron, Interaction Hall)
B Field Map
Tracking

Figure 1:

field map. This extra burden falls to the DCH as the only tracking subdetector visible from the fixed external reference.

2.2 Geometric Functions

A number of functions are required to provide access to geometry. These include:

- Track Position.
  Given a track described in the standard way and an arc length along that track, give the point in space. Also give the tangent direction to the track at that point.

- Track Error.
  Given a track described in the standard way and an arc length along that track, give the error description at that point (NOTE: requires material information, see below).

- Extrapolation.
  Given a track described in the standard way, predict the intersection point and error matrix projection onto either a planar or cylindrical surface. The intersection point object should include the track arc length at the intersection.

- Closest Approach.
  Given a track described in the standard way and a point in space, find the closest approach between the track and that point. The closest approach object should include the track arc length.

- Magnetic Bending.
  Given a track described as a simple helix and a starting and ending arc length, compute the new helix parameters at the ending arc length taking into account the non-uniform magnetic field (but not energy loss or other effects).

- Energy Loss.
  Given a track described as a simple helix and a starting and ending arc length, compute the new helix parameters at the ending arc length taking into account the (externally provided) energy loss (NOTE: requires material information, see below).

- Detector Position.
  Given a detector piece (SVT wafer, DCH wire, etc.) return a full description of its position in space. This should have the sub-option of returning only the active part of that piece.

3 Material Needs

Tracking access to Material information can be accomplished through access routines. This frees us from worrying about specific implementation of the material description, which is of more concern for ME and MC. We must however insist upon an 'accurate' description of the material that lies behind the access functions. Relevant dimensions for significant objects in the SVT is $\sim$ 1mm, DCH will have to decide if individual wires are needed. A list of access functions should include:

- Multiple Scattering.
  Given a track described in the standard way OR a simple helix, a particle mass, and a starting and ending arc length, compute the integral of the mean scattering angle dAlpha due to the material traversed.

- Energy Loss.
  Given a track described in the standard way OR a simple helix, a particle mass, and a starting and ending arc length, compute the integral of the average energy loss (dE/dX) due to the material traversed.

Functions for computing the probability of photon conversions, material interactions, and electron brehmstrahlung might also be provided, even though these don't fall formally in the domain of the tracking group.